Configurational factors in the perception of unfamiliar faces

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Abstract. Young et al (1987) have demonstrated that the juxtaposition of top and bottom halves of different faces produces a powerful impression of a novel face. It is difficult to isolate perceptually either half of the 'new' face. Inversion of the stimulus, however, makes this task easier. Upright chimeric faces appear to evoke strong and automatic configurational processing mechanisms which interfere with selective piecemeal processing. In this paper three experiments are described in which a matching paradigm was used to show that Young et al's findings apply to unfamiliar as well as to familiar faces. The results highlight the way in which minor procedural differences may alter the way in which subjects perform face-recognition tasks.

1 Introduction

Techniques such as Photofit and Identikit are based on the assumption that face recognition is achieved by analysing a face in terms of its component features (Penry 1971). However, there is growing evidence that the configuration of features within a face is a highly important factor in normal face recognition (eg Carey and Diamond 1977; Haig 1984; Sergent 1984; Ellis and Young 1988).

Young et al (1987) described an interesting phenomenon which they interpreted as evidence for configurational processing in face recognition. If a photograph of the top half of one face is aligned with the photograph of the bottom half of a different face, the two halves perceptually 'fuse' to produce a strong impression of a complete novel face. It becomes difficult to perceive either half of this chimeric face in isolation. Young et al quantified this effect by using composite faces made up of half faces from famous people. They asked subjects to make recognition judgments as quickly as they could, based solely on the top half of each face presented. The facial 'gestalt' produced by the chimeric faces made this task difficult to do: the irrelevant bottom half faces produced impressions of novel faces which interfered with performing the task of recognising the top halves alone. If the two face halves were grossly misaligned horizontally, or presented upside down, performance was enhanced. In fact, subjects were quicker to recognise the top halves of inverted faces (that is, top with respect to the face itself) than they were to recognise the top halves of upright faces.

This technique depends on asking subjects to recognise halves of familiar faces (celebrities) as quickly as possible. Young et al, aware of previously reported evidence of differences in the processing of familiar and unfamiliar faces, attempted to extend their findings to the latter in their third experiment. First, subjects were taught to recognise the top halves of faces in isolation. Subjects learnt a series of pairings between arbitrarily chosen names and the top halves of faces whose bottom halves the subjects never saw. These top halves were then combined with the bottom halves from a different set of faces to produce the experimental stimuli: 'composite' stimuli (in which the halves were aligned to produce a chimeric face) and 'noncomposite' stimuli (in which the halves were misaligned horizontally). By training subjects only on the top halves of the faces, Young et al hoped to ensure that subjects had no idea what the complete 'donor' faces looked like. The results from this experiment were similar to those from the previous experiments: the configurational effect produced by the composite stimuli significantly impaired recognition latencies. However, this is not a particularly convincing demonstration that Young et al's facial gestalt effect applies also to unfamiliar faces. It is conceivable that training on the half faces led to these effectively becoming familiar (if incomplete) faces, and hence being processed differently from truly unfamiliar faces. The issue of whether the configurational effect applies to faces which are truly unfamiliar to the subject is left unresolved.

In the experiments to be described below I used a slightly different technique, based on matching rather than recognition, in order to investigate this problem. Subjects were presented with a pair of wholly unfamiliar chimeric faces and were asked to decide as quickly as possible whether or not the top halves were identical. This technique obviates the necessity for subjects to have any prior experience with the faces or their components.

In experiments 1 and 2 I examined subjects' performance with upright and inverted chimeric faces, formed by pairing the top half of one face with the bottom half of another face. In experiment 3 I investigated the effects of chimeric faces formed by pairing different halves of vertically split faces, rather than horizontally split faces as in the previous two experiments. The rationale is the same in all three experiments: if the facial gestalt effect operates with completely unfamiliar faces, then subjects should be slower to make decisions about upright faces than about inverted faces, because of the difficulty of perceptually isolating parts of the face in the former condition.

2 Experiment 1: horizontally split chimeric faces, presented for 2 seconds

2.1 *Method*

2.1.1 *Subjects.* There were nineteen subjects, aged between 18 and 48 years. Three were male and sixteen female. All were unpaid volunteers, naive about the purpose of the experiment.

2.1.2 *Stimuli.* Subjects were presented with twenty-four cards, each bearing two monochrome high-contrast photographs of adult male faces (see figure 1).

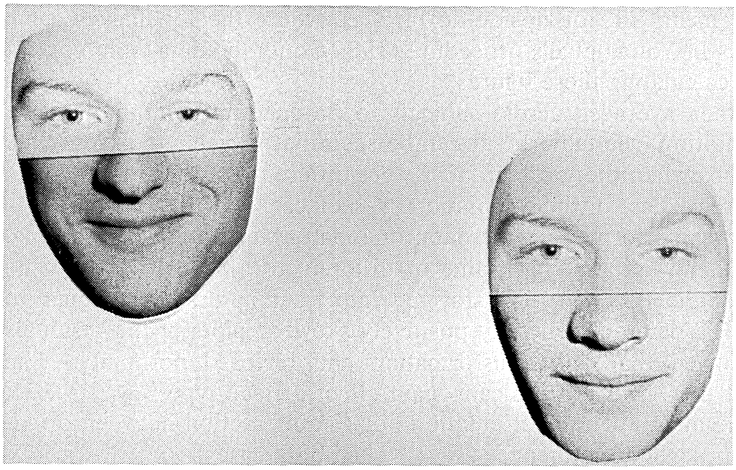
On each card there were two faces. Each face was a full-face view, made up of the top half of one face and the bottom half of a different face. Faces were horizontally sectioned halfway down the nose. Hair, ears, and neck were omitted; thus each face consisted principally of the internal features (eyes, nose, and mouth) plus the face outline.

On all the cards, the two faces were arranged diagonally. On half the cards the face on the left was higher than the face on the right, while for the rest of the cards the face on the right was higher. On twelve of the cards the top halves of the faces were identical (as in figure 1a), while for the other twelve cards the top halves were from different faces (as in figure 1b).

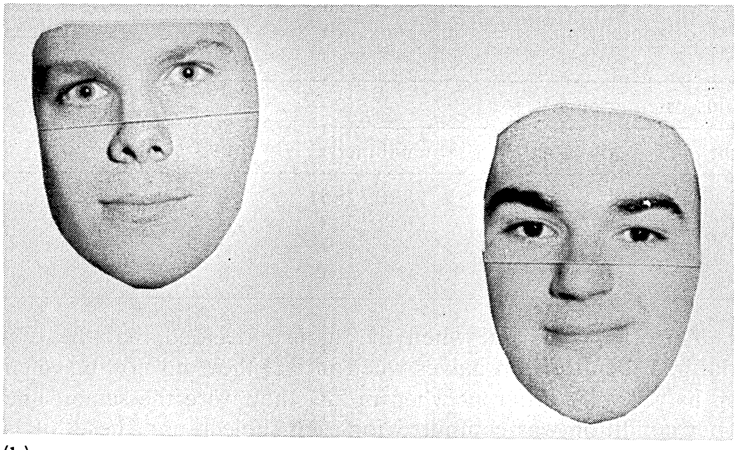
2.1.3 *Procedure.* Each subject was tested individually. Stimuli were presented via a single-field tachistoscope (BRD Electronics Ltd, model CT IV 'Cambridge'), controlled by a BBC microcomputer. The computer measured the time in ms between the onset of the stimulus presentation and the moment when subjects depressed either of two buttons on a button box in front of them. (The interrupts of the computer were disabled by software, in order to achieve a high level of timing accuracy).

Each card was presented for 2 s. A different random order of cards was used for each subject. Half of the subjects first saw the set of twenty-four cards upright, and were then shown them again, upside down. The other subjects first saw the cards upside down, and then saw them upright.

Subjects had to press either of the response keys, depending on whether the top halves of the faces on a card were identical or different. They were aware that



(a)



(b)

Figure 1. (a) Examples of stimulus cards for experiments 1 and 2, with horizontally split chimeric faces. In (a) the top halves of the faces are identical, whereas in (b) the top halves are from different faces.

reaction times for their choices were being measured, and were asked to respond as quickly but as accurately as possible. Two stimulus cards, randomly chosen from the pack of twenty-four, were shown to the subjects to clarify the task: they were given an example of a pairing to which they should respond "same", and one to which they should respond "different".

On each of the forty-eight trials, subjects were warned that the stimulus was about to be presented, by the experimenter saying "next"; he then pressed a button, which presented the stimulus and started the timing routine of the computer.

2.2 *Results*

For each stimulus presented, a record was taken of the subject's reaction time (RT) to make a decision about whether the top halves were the same or different from each other, and whether or not this was a correct decision.

2.2.1 *Reaction times.* For each subject, four mean RTs were computed: (a) the subject's mean RT for upright faces where the two top halves were from the same face; (b) the subject's mean RT for upright faces where the top halves came from different faces; (c) the mean RT for upside-down faces where the tops came from the same face; and (d) the mean RT for upside-down faces where the top halves came from different faces. As in Young et al's procedure (1987), only the data from correct decisions were used in calculating these figures.

These means were then averaged across subjects to produce means and standard deviations for each condition (see table 1). It can be seen that subjects took less time to make correct decisions when the top half faces were different than when they were identical. This was so regardless of the orientation of the faces.

A two-way ANOVA was performed on the data: one factor was orientation (normal or inverted) and the other was face type (same or different top halves). (Before the ANOVA was performed, the RTs were transformed into their natural logarithms, to allow for the fact that RT data are generally positively skewed; plots of the residuals for each condition showed that this transformation had restored normality.) The ANOVA confirmed that there was a significant main effect of face type ($F_{1,18} = 7.25$, $p < 0.015$). Neither the main effect of orientation nor the interaction between orientation and face type approached significance ($F_{1,18} < 1$ in both cases).

Table 1. Mean reaction times (in ms, with standard deviations in parentheses) for correct decisions in experiment 1 (horizontally split faces presented for 2 s). Data are from nineteen subjects.

Stimulus type	Stimulus orientation		
	upright	inverted	combined
Same faces	1872 (773)	1868 (819)	1870 (785)
Different faces	1597 (465)	1684 (611)	1641 (538)
Combined	1735 (645)	1776 (719)	

2.2.2 *Number of errors.* An error occurred when the subject decided that the two faces presented on a trial had identical top halves when in fact they did not, or when subjects decided the top halves were different when in fact they were the same. The total number of errors per condition was computed for each subject, and these totals were used to calculate error rates for each permutation of orientation and similarity/dissimilarity.

The overall error rate was 18%. A two-way ANOVA on the error rates revealed a significant interaction between orientation and face type ($F_{1,18} = 5.74$, $p < 0.05$); inspection of the mean error rates for each permutation of conditions suggests that this is attributable to the fact that subjects made most errors with the upright/identical faces (26%) and fewest errors with the upright/different faces (13.6%). Error rates for the inverted faces were similar whether the faces were the same (16.7%) or different (17.1%). There were no significant main effects of orientation ($F_{1,18} = 1.40, p > 0.20$) or face type ($F_{1,18} = 3.37, p < 0.10$).

2.3 *Discussion*

In apparent contradiction to Young et al's (1987) findings, subjects were no quicker at making judgments about faces when those faces were presented inverted than when they were shown normally oriented. A number of subjects spontaneously remarked that the matching task seemed harder with the upright faces than with the inverted faces, although this was not borne out by their RT data. Some subjects also mentioned that they had used a piecemeal, feature-by-feature matching strategy, in order to overcome any 'gestalt' effects induced by the chimeric faces. They searched for a distinctive feature on one half face (such as an eyebrow or the shape of the white space between eyebrow and eye), and then looked for the presence or absence of this feature on the other face. If this is so, it would account for two aspects of the data.

First, it would explain why subjects were taking a relatively long time to make their decision (ie most of the 2 s presentation time). Second, it would account for the significant main effect on the face-type factor. Subjects took longer to make their decisions when the two half faces were the same than when they were different. This could be explained as follows: if subjects resorted to a process of serial comparison between isolated facial features, which terminated upon detection of a mismatch between the two half faces, the subjects would need to compare only one or two features in order to decide that the faces were different, but they would need to compare all (or most) of the features before they could conclude that the faces were the same. It seems that this experiment has failed to provide evidence of configurational effects in the processing of upright chimeric faces because the task encouraged subjects to adopt a feature-matching strategy.

3 Experiment 2: horizontally split chimeric faces presented for 80 ms

Some subjects in experiment 1 reported that they attempted to use a piecemeal feature-matching strategy to perform the task. In experiment 2 I attempted to forestall this individual-feature-matching strategy by making the exposure duration too short for subjects to get anything other than a single brief glance at each face.

Experiment 2 was identical to experiment 1, except that the exposure duration was reduced from 2 s to 80 ms.

3.1 *Method*

3.1.1 *Subjects.* Twenty-two subjects took part, none of whom had participated in the previous experiment. Eleven were male, and eleven female.

3.2 *Results*

3.2.1 *Reaction times.* The data were analysed in the same way as for experiment 1. The means and standard deviations for each of the four permutations of orientation and face type are shown in table 2. It can be seen that subjects were faster to make correct decisions about inverted faces than they were about upright faces. A two-way ANOVA was performed on the log-transformed data; one factor was orientation (normal or inverted) and the other was face type (same top halves or different). There was a significant effect of orientation ($F_{1,21} = 8.67$, $p < 0.01$). Neither the main effect of face type nor the interaction between orientation and face type approached significance ($F_{1,21} = 2.78$ and $F_{1,21} = 1.91$, respectively; for both, $p > 0.10$).

Table 2. Mean reaction times (in ms, with standard deviations in parentheses) for correct decisions in experiment 2 (horizontally split faces presented for 80 ms). Data are from twenty-two subjects.

Stimulus type	Stimulus orientation		
	upright	inverted	combined
Same faces	1230 (205)	1113 (193)	1171 (205)
Different faces	1161 (233)	1110 (200)	1136 (216)
Combined	1196 (220)	1112 (194)	

3.2.2 *Number of errors.* There were no statistically significant differences in error rates between the four conditions. However, the same pattern of errors was found as in experiment 1. The overall mean error rate was 21.7%. Most errors were made with upright/identical faces (26.2%), fewest errors were made with upright/different faces (16.2%), and the error rates for inverted/same and inverted/different faces were roughly comparable (20.8% and 23.5%, respectively).

3.3 *Discussion*
In this experiment, subjects took longer to make similarity judgments about upright chimeric faces than they did to make judgments about inverted chimeric faces. The upright faces appear to have evoked configurational processing of the entire face, processing which made it relatively difficult for the subjects to isolate the top half of the face perceptually. These results differ from those of experiment 1 and confirm Young et al's (1987) findings, extending them to totally unfamiliar faces.

The reason for the discrepancy between the results of experiments 1 and 2 is that the very brief exposure durations used in experiment 2 prevented subjects from resorting to the feature-by-feature processing strategy that they had successfully used in experiment 1, and encouraged the use of a wholistic strategy based on the configurational properties of the stimuli. In Young et al's original experiment (1985), subjects had little opportunity to use a piecemeal strategy, by virtue of the nature of their face-identification task. Taken together, the results of experiments 1 and 2 reveal something not shown by Young et al's experiments, that, given differing task demands, subjects may switch to whatever seems to be the most effective strategy for performing the task.

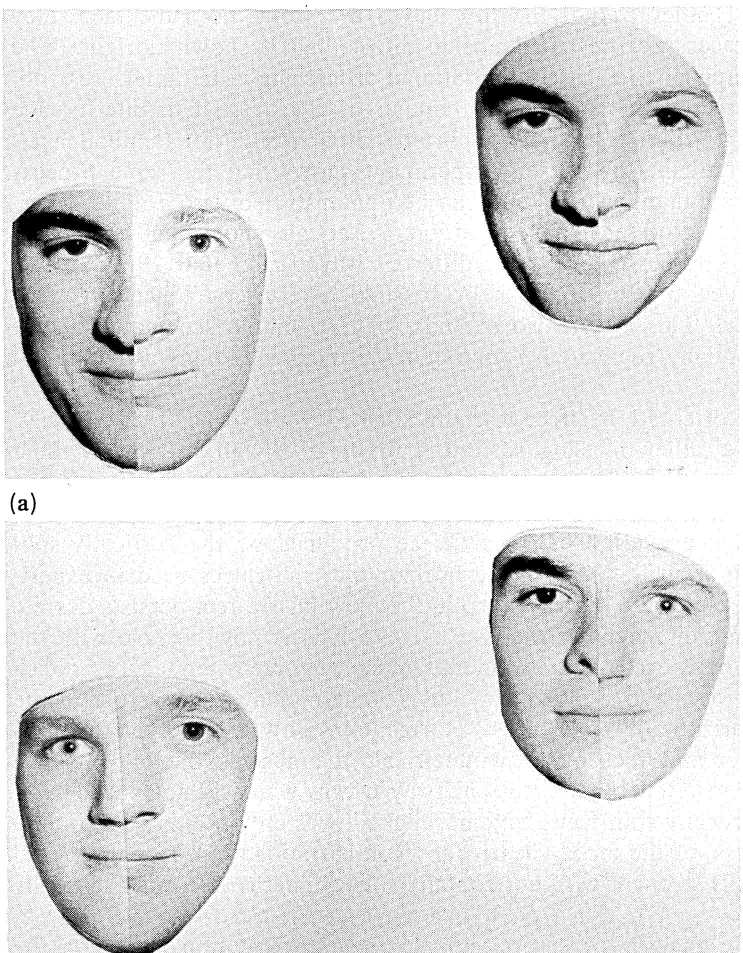
4 Experiment 3: vertically split chimeric faces, presented for 80 ms
This experiment was identical to experiment 2, except that the faces were split vertically rather than horizontally (see figure 2). Subjects had to decide as quickly but as accurately as possible whether the left halves of the two faces presented were the same (as in figure 2a) or different (as in figure 2b). Faces were split along a line running vertically through the middle of the nose.

To remove any potential ambiguity about what was meant by 'left', a card containing faces was presented to the subjects before each set of presentations, and the halves of the two faces which were to be compared were pointed to.

4.1 *Method*
4.1.1 *Subjects.* Twenty-one subjects took part (five male and sixteen female), none of whom had participated in the previous experiments.

4.2 *Results*
4.2.1 *Reaction times.* The data were analysed in the same way as for experiments 1 and 2. For each subject, four mean RTs were computed (upright/same left halves, upright/different left halves, inverted/same left halves, and inverted/different left halves). These means were averaged across subjects to produce the means and standard deviations shown in table 3. It can be seen that subjects showed little difference in their RTs to vertically split faces, regardless of condition—except that inverted/same left-half faces appear to have been responded to slightly faster than faces in the other conditions. A two-way ANOVA was performed on the log transforms of these data, with orientation (normal or inverted) as one factor and face type (same or different left halves) as the other factor. No significant differences were found between the four conditions for the main effects of orientation ($F_{1,20} = 0.28$) and face type ($F_{1,20} = 2.13$). However, the interaction of orientation and face type was significant ($F_{1,20} = 4.44$, $p < 0.05$). There was an orientation effect (with inverted faces being responded to more quickly than upright faces), but this was limited to comparisons involving identical left-half faces. No inversion effect was obtained when the comparisons involved different left-half faces.

4.2.2 *Number of errors.* A statistically significant interaction was found between face type and orientation ($F_{1,20} = 16.23$, $p < 0.001$). Neither of the main effects approached significance. The overall mean error rate was 20.8%. A similar pattern of errors was found to that in the previous two experiments, inasmuch as the highest number of errors was made in the upright/identical condition (26.6%) and the lowest in the upright/different condition (13.1%). However, error performance on the inverted stimuli differed from that in the previous experiments: the mean error rate was 17.8% for the inverted/identical stimuli and 25.6% for the inverted/different stimuli.



(a)

(b)

Figure 2. Examples of stimulus cards for experiment 3, with vertically split chimeric faces. In (a) the left halves of the faces are identical, whereas in (b) the left halves are from different faces.

Table 3. Mean reaction times (in ms, with standard deviations in parentheses) for correct decisions in experiment 3 (using vertically split faces presented for 80 ms). Data are from twenty-one subjects.

Stimulus type	Stimulus orientation		
	upright	inverted	combined
Same faces	1275 (233)	1196 (236)	1235 (235)
Different faces	1269 (299)	1268 (381)	1269 (338)
Combined	1272 (265)	1232 (315)	

5 General discussion

The results of the experiments described here both confirm and extend the original findings of Young et al (1987).

The results of experiment 2 confirm Young et al's findings by demonstrating that the configurational effects described by these authors can also occur with completely unfamiliar faces. If subjects are presented very briefly with a pair of chimeric faces and asked to decide whether or not the top halves are from the same face, they respond faster if the faces are presented upside down than if shown upright. The upright chimeric faces appear to elicit configurational processing which interferes with the subject's task of perceptually isolating components of the faces. This interference is removed by inversion. Young et al have reported similar results for familiar faces, using a recognition paradigm; the present experiment shows that the same process appears to operate with unfamiliar faces and can be demonstrated with a quite different task, involving matching rather than recognition. Although familiar and unfamiliar faces are thought to be processed in rather different ways (Ellis et al 1979; Young et al 1985), upright faces appear to evoke processing in terms of a 'facial gestalt' regardless of familiarity. This effect also extends to very simple schematic faces—Endo et al (1989) essentially replicated Young et al's principal findings using stimuli of this sort.

In experiment 3 the orientation effect was investigated with vertically split faces. The results obtained are rather puzzling, since it is not clear why an orientation effect should only be obtained with vertically split faces when the face halves being matched were identical. My subjective impression while constructing the stimuli for these experiments was that the evocation of a 'new' face produced by the vertically split faces was not as strong as in the case of the horizontally split faces used in experiments 1 and 2. In the case of the horizontal split, the 'new-face' effect persists despite moderate amounts of misalignment of the two halves. This is not the case with the vertically split faces, where even a small amount of misalignment tended to abolish the effect. Quite why this is so is not clear, but symmetry may have a role in the effectiveness of the horizontally split faces. Horizontal splitting leaves all features within a half-face intact and reasonably symmetrical; the nose is the only feature whose appearance is corrupted by a 'break' halfway down, which is not particularly salient. In contrast, vertically split faces have misaligned eyes and mouths, which tend to lessen the 'naturalness' of the face. Clearly, any configurational processing evoked by these chimeric faces is stronger with horizontally split chimeras than with vertically split ones.

The results from the analysis of errors support the interpretation based on the RT data. In all three experiments subjects experienced more difficulty (in the sense that they made more errors) with the upright/identical condition than with the other permutations of orientation and face type. In contrast, subjects tended to make fewest errors in the upright/different condition. (This was a statistically significant effect for experiments 1 and 3, but only a trend for experiment 2). This pattern of results can be explained as follows. The faces presented consisted of two halves: one half of each face could be the same as the corresponding half of the other face or it could be different. (These were the target halves, which the subjects were attempting to compare). The other half faces (the distractor halves, which the subjects were trying to ignore) were always different from each other. Suppose that the distractor half faces in some way affected the appearance of the target half faces. Since the distractor halves are always different, each will exert a different effect on its adjacent target half face. This will have two effects. It will tend to make the target halves appear different when they are in fact the same, thus increasing the number of errors in the upright/identical condition; and it will increase the apparent difference between the target halves when they are actually different anyway, thus reducing the number of errors in the upright/different condition. The implication of this is that these chimeric faces may do more than just produce an overall impression of a 'new' face; they may also change the appearance of the features within the component halves. An eye or a nose within one facial context might appear quite different from the very same feature embedded within a different face. If so, this would have important implications for Photofit techniques, etc.

The results of the present experiments highlight the way in which task requirements can markedly affect subjects' behaviour. (As an anonymous reviewer pointed out, this is no cause for surprise!) In experiment 1, the use of a comparatively long exposure duration encouraged subjects to use a feature-by-feature matching strategy in order to perform the task demanded of them. The result of this was that no effect of inversion was found. In experiment 2, a minor change of procedure (reduction of the exposure time from 2 s to 80 ms) caused subjects to adopt a quite different strategy based on global matching between the faces presented. A slight procedural alteration produced a very different picture of what was going on.

It should be noted that Young et al (1987), by asking subjects to identify famous half faces as quickly as possible, incidentally placed a premium on using a global encoding strategy rather than a piecemeal one. This does not invalidate Young et al's conclusions in any way, but it does suggest that there might be circumstances in which subjects might prefer a feature-encoding strategy (eg when attempting to recognise the British politician Denis Healey, who has strikingly bushy eyebrows). As Young et al point out, "configurational and featural information are ... both likely to contribute to normal face recognition" (1987, page 758), and the task is to specify how these two kinds of cue interact. The implication of the present study is that the answer to questions such as 'do subjects use configurational or piecemeal encoding strategies?' may depend crucially on the task (Sergent 1984; Bruce 1988). We should be open to the possibility that people use the strategy most appropriate to the task—whether that task is doing the experimenter's task well, or extracting information from faces in 'natural' situations. Clearly, one must ensure that the tasks used in laboratory studies of face recognition encourage subjects to perform processing in ways comparable to those used in 'real-life' situations. Since we have no a priori means of knowing which strategies are naturally used by subjects and which are not, this suggests that we should try to check on the validity of established findings by using diverse techniques—in the same way as the present series of experiments support Young et al's conclusions, by using different methods.

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References

Bruce V, 1988 *Recognising Faces* (London: Lawrence Erlbaum Associates)

Carey S, Diamond R, 1977 "From piecemeal to configurational representation of faces" *Science* **195** 312 - 314

Ellis H D, Shepherd J W, Davies G M, 1979 "Identification of familiar and unfamiliar faces from internal and external features: some implications for theories of face recognition" *Perception* **8** 431 - 439

Ellis H D, Young A W, 1988 "Are faces special?", in *Handbook of Research on Face Processing* Eds A W Young, H D Ellis (Amsterdam: Elsevier)

Endo M, Masame K, Kinya M, 1989 "Interference from configuration of a schematic face onto the recognition of its constituent parts" *Tohoku Psychologica Folia* **48**(1 - 4) 97 - 106

Haig N D, 1984 "The effect of feature displacement on face recognition" *Perception* **13** 505 - 512

Penry J, 1971 *Looking at Faces and Remembering Them* (London: Elek Books)

Sergent J, 1984 "An investigation into component and configural processes underlying face perception" *British Journal of Psychology* **78** 221 - 242
Young A W, Hay D C, McWeeny K H, Flude B M, Ellis A W, 1985 "Matching familiar and unfamiliar faces on internal and external features" *Perception* **14** 737 - 746
Young A W, Hellawell D, Hay D C, 1987 "Configurational information in face perception" *Perception* **16** 747 - 759